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13. ABSTRACT (Maximum 200 words)  This report describes the equipment purchased under ARO Research Instrumentation Grant No. DAAH04-94-G-0386. This equipment has been used to support the ARO research program entitled, "Fluid Dynamic Mechanisms and Interactions with Separated Flows" (ARO Grant No. DAAH04-93-G-0226). In particular, instrumentation has been purchased to obtain measurements and flow visualizations using schlieren and shadowgraph photography, laser Doppler velocimetry, particle image velocimetry, and Mie/Rayleigh scattering. The specific pieces of equipment, vendors, and purchase prices are detailed.				
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## **FINAL PROGRESS REPORT**

### **Research Instrumentation for "Fluid Dynamic Mechanisms and Interactions within Separated Flows"**

**ARO Grant No. DAAH04-94-G-0386**

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## **1. INTRODUCTION**

The purpose of the subject instrumentation grant was to purchase several pieces of equipment to be used in conjunction with an ongoing ARO-funded research grant entitled "Fluid Dynamic Mechanisms and Interactions within Separated Flows" (ARO Grant No. DAAH04-93-G-0226). The research efforts of this latter program are focused on experimental investigation of the fundamental fluid dynamic mechanisms within separated flow regions embedded in high-speed flows. In particular, the long term objective of the program is to improve understanding of the detailed flow processes in the near-wake of missile and projectile-type base flows with the goal of controlling these flows to derive flight vehicle performance benefits. The particular tasks within this program that have benefited from the purchase of the equipment listed below are: (1) investigation of the conditionally sampled mean velocity and turbulence fields of a plume-induced separated flow; (2) planar visualization and turbulence measurements in an axisymmetric base bleed flow with a supersonic freestream; and (3) PIV measurements of the time-resolved planar velocity field in incompressible and compressible free shear layers and base flows.

In addition to the work described above, the AASERT grant entitled "The Role of Large Structures in Compressible Reattaching Shear Flows" (ARO Grant No. DAAL03-92-G-0129) has utilized the equipment purchased under this instrumentation grant, particularly the gated, intensified CCD camera listed below. The research objective of this AASERT grant is to examine the role, dominance, and influence of large turbulent structures in the near-wake region of a base flow with

supersonic freestreams. This has been accomplished by an extensive planar Mie/Rayleigh scattering visualization study together with detailed statistical analyses of the image ensembles.

As discussed briefly below, in most cases purchase and use of the new equipment were necessary to replace hardware that had failed due to normal usage over an extended lifetime. Purchase of this equipment has therefore maintained and strengthened our ability to make significant contributions to the research area of compressible, separated flows, which is of direct importance to the U.S. Army.

## **2. EQUIPMENT PURCHASED**

Listed below are the pieces of equipment that have been purchased with the funds provided with this instrumentation grant. Hardware purchases that were unexpectedly required are the upgrade to our particle image velocimeter (PIV) interrogation system and replacement of a PMT system for our two-component laser Doppler velocimeter (LDV). The PIV interrogation upgrade was necessary due to the failure of the array processor board in our original system. Since repair of the original board, which is now quite outdated, would have cost a significant fraction of the expenditure required for a new system, we opted to purchase new equipment. The replacement hardware has approximately five times the computational power of the original system. One of the PMT systems for our two-component LDV also required replacement due to an unreparable electronic noise problem that occurred.

A detailed listing of the equipment purchased, together with the vendor and price, are given below.

<u>Item</u>	<u>Vendor</u>	<u>Price</u>
<b>Schlieren/Shadowgraph Components</b>		
Nanolamp spark light source	Xenon Corp.	\$3115
<b>LDV Components</b>		
Direct Memory Access (DMA) card	TSI Inc.	\$1174
PMT system	TSI Inc.	\$7151

<u>Item</u>	<u>Vendor</u>	<u>Price</u>
<b>PIV Interrogation System Components</b>		
Digital Signal Processing (DSP) equipment	Innovative Integration	\$11,305
90 MHz Pentium-based computer	Comtrade	\$2395
<b>Laboratory Computer Systems</b>		
66 MHz 486-based computer for LDV system	Swan Technologies	\$2287
66 MHz 486-based computer for digital camera system	Dell Inc.	\$1638
Digital scanner	Lacie Ltd.	\$1297
600 DPI laser printer	UIUC Computer Stores	\$1066
<b>Harmonic Crystal for Nd:YAG Lasers</b>		
Fourth harmonic generator	Continuum Laser Products	\$4000
<b>Gated, Intensified CCD Camera System</b>		
Frame grabber	Data Translation	\$1964
Computer monitor	Martco	\$135
System fabrication	Electro Optical Services	\$4029
CCD digital camera	Hamilton Hallmark	\$984
CCD camera lens	Helix	\$780
CCD image intensifier	Ziemer and Associates	<u>\$3680</u>
<b>Total Funds Expended</b>		<b>\$47,000</b>

The University of Illinois at Urbana-Champaign, together with this principal investigator and his graduate student research colleagues, sincerely appreciates this investment of ARO instrumentation funds in our research program.